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Environmental Restoration Project
Standard Operating Procedure

for:

Performing Background Value Comparisons for Radionuclides

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Performing Background Value Comparisons for Radionuclides

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NOTE: Environmental Restoration (ER) Project personnel may produce paper copies of this procedure printed from the controlled-document electronic file located at http://erinternal.lanl.gov/documents/Procedures/sops.htm. However, it is their responsibility to ensure that they are trained to and utilizing the current version of this procedure. The Quality Program Project Leader may be contacted if text is unclear.

1.0 PURPOSE

This Standard Operating Procedure (SOP)describes the process for performing background value comparisons and fallout value comparisons on radionuclides at the Los Alamos National Laboratory (the Laboratory) ER Project.

2.0 TRAINING

2.1 All users of this SOP are trained by self-study, and the training is documented in accordance with QP-2.2.

2.2 The **Team Leader** will monitor the proper implementation of this procedure and ensure that relevant team members have completed all applicable training assignments in accordance with QP-2.2.

3.0 DEFINITIONS

3.1 *Artificial fill* — A material that has been imported and typically consists of disturbed soils mixed with crushed Bandelier Tuff or other rock types.

3.2 *(Laboratory) background data* — Data that represent radioactivity concentrations associated with naturally occurring radionuclides or fallout radionuclides not affected by the Laboratory. Laboratory background data are derived from samples collected from locations within or neighboring the Laboratory that (1) are representative of geological media found within Laboratory boundaries and (2) have not been affected by Laboratory operations.

3.3 *Background value (BV)* — A concentration of an inorganic chemical or a radionuclide used as a simple threshold value to identify if potentially contaminated site sample results are greater than background levels. A BV is either an upper tolerance limit (UTL) calculated from the Laboratory's background data or the detection limit for the analytical method used on the Laboratory's background data. UTLs are 95% upper confidence bounds on the 95th percentile of background sample concentrations in a specific

geological sample medium (or group of media). BVs are the same as, and were formerly referred to as, background screening values. For tuff media, the BV calculations for radioactive isotopes of potassium, uranium, and thorium are based on total elemental (mass) concentrations of these elements in the Laboratory's background samples. The BVs of progeny radionuclides are estimated from the parent radionuclide, assuming secular equilibrium.

3.4 *Canyon sediment* — A sample media group that consists of young alluvium in or near stream channels within a canyon.

3.5 *Fallout radionuclides* — Radionuclides that are present at globally elevated activities in the environment as a result of the fallout from atomic weapons tests. The Laboratory background data sets consist of samples taken from marginal and regional locations for the following radionuclides associated with fallout: tritium, cesium-137, americium-241, plutonium-238, plutonium-239/240, and strontium-90. Samples were collected from regional and marginal locations in the vicinity of the Laboratory that (1) are representative of geological media found within Laboratory boundaries and (2) were not affected by Laboratory operations.

3.6 *Fallout value (FV)* — A concentration of a fallout radionuclide used as a simple threshold value to identify if potentially contaminated site surface sample results are greater than background levels. A FV is either an upper tolerance limit (UTL) calculated from the Laboratory's background data or, for tuff media, a nominal minimum detectable activity (MDA) for the analytical method used on the Laboratory's background data. UTLs are 95% upper confidence bounds on the 95th percentile of background sample concentrations in a specific geological sample medium (or group of media). FVs are the same as, and were formerly referred to as, background screening values. Whenever MDAs are used as FVs, it is intended that samples be evaluated on the basis of detection status rather than by comparison to the tabled MDA.

3.7 *Naturally occurring radionuclides* — Radionuclides that are present in the environment from background sources such as the natural composition of geologic rock units and other media. The Laboratory's background data for naturally occurring radionuclides have been analyzed for, and hence are limited to, potassium-40, uranium and uranium decay-chain products, thorium and thorium decay-chain products, including: radium-226, radium-228, thorium-228, thorium-230, thorium-232, uranium-234, uranium-235 and uranium-238. The Laboratory's background samples have been collected from locations within or neighboring the Laboratory that (1) are representative of geological media found within Laboratory boundaries and (2) have not been impacted by Laboratory operations.

3.8 *Qbt 1g, Qbo, Qct* — A sample media group that is comprised of three rock units: the Tshirege Member of Bandelier Tuff cooling unit 1g, Cerro Toledo interval, and Otowi Member of Bandelier Tuff. These media are encountered during deep drilling investigations on mesa tops. They can also be encountered on canyon walls or in lower reaches of canyons. BVs are not available for the individual rock units in this sample media group.

3.9 *Qbt 1v* — A sample medium that is comprised of one rock unit (Tshirege Member of Bandelier Tuff cooling unit 1v) from Bandelier Tuff. This medium is encountered during deep drilling investigations on mesa tops. This medium can also be encountered on canyon walls or in lower reaches of canyons.

3.10 *Qbt 2, Qbt 3, Qbt 4* — A sample media group that is comprised of three rock units from upper part of the Tshirege Member of Bandelier Tuff. These upper Bandelier Tuff cooling units underlie most mesa-top PRSs. BVs are not available for the individual rock units in this sample media group.

3.11 *Soil* — A sample media group that includes soil and can include artificial-fill materials. Soil refers to a material that overlies bedrock and which has been subject to soil-forming processes. The sample media group of soil includes soils from all soil horizons.

Note: These group definitions describe sample media in simplistic terms. For more detailed definitions, see the Laboratory's background data document (Ryti et al. 1998, 59730.2).

3.12 *Surface sample* — A sample taken at a collection depth that is (or was) representative of the medium's surface during the time period of investigative interest. A typical surface sample depth interval is zero to six inches for mesa-top locations, but may be up to several feet deep in sediment-deposition areas in canyons.

4.0 BACKGROUND AND PRECAUTIONS

4.1 Comparing Analytical Methods

4.1.1 If the analytical methods chosen for the site data were different from those used for the Laboratory's background data, determine if the methods are comparable.

4.1.1.1 The comparison of site analytical results with a BV or FV is meaningful only when the site's samples are analyzed using methods that are comparable to those used on the Laboratory's background samples. The sample-preparation and analytical methods used for all the Laboratory's background data sets are listed the Laboratory's background data document (Ryti et al. 1998, 59730.2). Because

radiochemical analyses are not as standardized as inorganic analyses, this issue is an even greater pitfall for radionuclide analyses than for inorganic analyses. For example, some radionuclides may be analyzed using more than one method, with multiple options for sample preparation, counting geometries, and counting times possible for each method.

4.1.1.2 Uranium-235 is one example of a radionuclide that may cause difficulty. The BV for uranium-235 is based on alpha spectroscopy analysis of the Laboratory's background samples, and the BV is smaller than the typical minimum detectable activity for this isotope when it has been analyzed by gamma spectroscopy. Consult an ER Project Chemistry Team member for help with determining which analytical methods are comparable.

4.2 Determination of Radionuclide Detection Status

4.2.1 Before eliminating a radionuclide with no results greater than the MDA, determine that the detection status was reviewed by a chemist.

4.2.1.1 The ER Project has a recommended procedure by which analytical data reports are reviewed to ensure that inadequate counting time or interference did not lead to erroneous activity results. If all RCRA facility investigation (RFI) data has undergone the current ER Project validation process, the detection status has been determined and is reflected in the final (RFI) qualifiers. If a portion of the radionuclide data being used in was collected, reported, and/or validated under prior standards, check with the focus area responsible for the report for direction on how to proceed.

4.2.1.2 If possible, the data should be reviewed by a chemist who is familiar with ER Project guidance for determining detection status of legacy data that comes from the ER Project database. Using the reporting limit provided in the ER database as a data screening tool is valid only when the data package from the analytical laboratory meets the general guidelines available in the statement of work for radiochemical analyses (LANL 1995, 49738). Using different criteria for determining if a radionuclide has detection status may compromise the comparability of the data sets.

4.3 Some Radionuclides Reported in Analytical Laboratory Data Packages can be Eliminated from Evaluation

4.3.1 The radiological data packages returned by analytical laboratories typically contain indicator compounds designed to indicate the level of quality of the data. These indicator compounds are used by both the analytical laboratory and the ER Project for a QC evaluation of the data package. They do not typically represent suspected site contaminants. Thus, it is inappropriate to compare these compounds to BVs/FVs.

4.3.2 If site data were analyzed using gamma spectroscopy, the ER Project recommends that professional judgement be used for evaluating some of the radionuclides contained in the standard reported analyses, including radionuclides considered to be “not reliably measured” by gamma spectroscopy and some radionuclides with half-lives of less than 365 days. The “Approach to Gamma Spectroscopy Data Quality Evaluation” guidance document (ER Project 2000, **65089**) lists the gamma spectroscopy analytes that are reliably measured and typically evaluated as potential historical contaminants at ER Project sites: uranium-235 and seven fission and activation products (americium-241, cobalt-60, cesium-134, cesium-137, europium-152, sodium-22, and ruthenium-106).

4.3.3 Consult an ER Project Chemistry Team member for information about the radionuclides reported in the gamma spectroscopy suite, and those that may be eliminated from the suite upon consideration of the operational history at the PRS.

4.4 Fallout Radionuclides Detected in Subsurface Soils Samples and Tuff Samples

4.4.1 Because radionuclides resulting from fallout are associated with atmospheric deposition, the background activity of this class of radionuclides is limited to surface samples at relatively undisturbed sites. If a fallout radionuclide is detected in any subsurface soil sample or tuff sample, assume that the radionuclide exceeds background. Surface exposed unweathered bedrock is not typically considered to be affected by fallout.

4.4.2 Soil samples taken from levels greater than 6 inches below ground surface can be considered fallout-affected if the soils were at surface locations at some time during Laboratory operations and the resulting layer is currently deeper than 6 inches. ER Project personnel must present reasonable justification that the sample is (or was) representative of the surface, and thus was exposed to fallout, and include supporting documentation. Sediments deposited in runoff

channels generally derive from surface location sources and are potentially fallout-affected throughout the deposit.

4.5 Tuff Background Data Samples that were Taken from Unweathered Tuff

If tuff from a site is noted as weathered, a geologist or geochemist should be consulted to verify that the weathered tuff sample is comparable to the unweathered tuff used to calculate the Laboratory's background data. In some cases, it may be more appropriate to compare the PRS samples of naturally occuring radionuclides from weathered tuff to the soil BVs or canyon sediment BVs from the Laboratory's background data, depending on the sample locations.

4.6 Using the Logic Diagram

ER Project workers who are familiar with this SOP may use the logic diagram included as Figure 6.15-1 (see page 11) to perform the background value comparison. Further explanation of the details is provided in the procedure section, below.

5.0 EQUIPMENT

A computer or calculator (optional).

6.0 PROCEDURE

Note: Deviations from SOPs are made in accordance with QP-4.2.

6.1 Prepare for BV/FV Comparisons

6.1.1 The **ER Project worker** begins by obtaining a current list of BVs and FVs. This information is available from the Laboratory's background data document (Ryti et al. 1998, 59730.2) or from the Facility for Information Management, Analysis, and Display (FIMAD) table `BKGD_VALUE_INFO`.

6.1.2 Obtain current list of sample-preparation and analytical methods that were used to calculate the Laboratory's background radionuclides. This information is available from the Laboratory's background data document (Ryti et al. 1998, 59730.2) or from FIMAD table `BKGD_VALUE_INFO`.

6.1.3 From the appropriate Focus Area, obtain the sample results for the PRS being evaluated, including sample activity concentration results, reporting units of the sample activity concentrations, final (RFI) sample-result qualifiers, sample analytical methods, and sample-preparation methods.

Note: The PRS data set may be provided to the user in the same format as it is recorded in FIMAD. It is assumed that the user has familiarity

with the definitions and use of the data fields in FIMAD. Data dictionaries and code definitions are available. (For copies of the dictionaries and codes, as well as answers to specific questions, contact the ER Project's Centralized Data Management group.) The final (RFI) qualifiers are not listed in FIMAD but are provided by the focus area preparing the report.

6.1.4 Determine the comparability of the methods used to prepare and analyze the site samples and the background samples. Document the conclusions in the format requested by the focus area for the report.

Note: If PRS sample methods differ from the Laboratory's background methods and professional advice is needed, consult an ER Project Chemistry Team member.

6.1.5 Verify that a radiochemist (or other subject area expert) has reviewed the analytical data report and made the determination of detection status. Document the conclusions in the format requested by the focus area for the report.

Note: The issues involved in this determination are listed in Section 4.0, Background and Precautions.

6.2 Eliminate Extraneous Radionuclides from Evaluation

6.2.1 Eliminate those radionuclides that had been included for QA/QC purposes and those that are not typically evaluated as potential historical contaminants.

Note: If gamma spectroscopy was used, see Section 4.0, Background and Precautions.

Note: If potassium-40 was identified for investigation at the PRS, it should be treated in the same manner as other naturally occurring radionuclides (i.e., compared to the appropriate BV). Otherwise, treat it as a data quality analyte (i.e., no evaluation).

6.2.2 Eliminate appropriate radionuclides based on detection status.

Note: Eliminate the radionuclides that had no results reported as detected. For precautions, see Section 4.0, Background and Precautions.

6.3 If the radionuclide is not on the list of radionuclides associated with fallout (i.e., tritium, cesium-137, americium-241, plutonium-238, plutonium-239/240, and strontium-90), proceed to Section 6.8.

6.4 If the PRS samples were collected from soil media and a fallout radionuclide was detected at any subsurface samples, identify the radionuclide as a chemical of potential concern (COPC) and carry it forward to a dose- or risk-based assessment without further evaluation.

6.5 If the PRS samples were collected from soil media (including any soil, with or without identified horizons, and/ or geological fill material) and a fallout radionuclide was detected in surface samples only, select the Laboratory's soil FVs and proceed to Section 6.14.

6.6 If the PRS samples were collected from tuff media, identify any detected fallout radionuclide as a COPC and carry it forward to a dose- or risk-based assessment.

Note: Tuff samples are evaluated on the basis of detection status alone. Although FVs for rock tuff units are listed in the Laboratory's background data document (Ryti et al. 1998, 59730.2), the values listed are nominal minimum detectable activity levels and should not be used to determine if site activities exceed background.

6.7 If the PRS samples were taken from canyon sediment samples, select canyon sediment FVs and proceed to Section 6.14.

6.8 If the radionuclide is not in the list of naturally occurring radionuclides (i.e., potassium-40, radium-226, radium-228, thorium-228, thorium-230, thorium-232, uranium-234, uranium-235, and uranium-238), identify the radionuclide as a COPC and carry it forward to a dose- or risk-based assessment without further evaluation.

6.9 For PRS samples that contain naturally occurring radionuclides and that were collected from soil media (including any soil, with or without identified horizons, and/ or geological fill material), select the Laboratory's soil BVs and proceed to Section 6.14.

6.10 For PRS samples that contain naturally occurring radionuclides and that were collected from tuff units Qbt 2, Qbt 3, and/or Qbt 4, select the Qbt 2, Qbt 3, and Qbt 4 sample media group from the Laboratory's BVs and proceed to Section 6.14.

6.11 For PRS samples that contain naturally occurring radionuclides and that were collected from tuff unit Qbt 1v, select Qbt 1v from the Laboratory's BVs and proceed to Section 6.14.

6.12 For PRS samples that contain naturally occurring radionuclides and that were collected from tuff units Qbt 1g, Qct, and/or Qbo, select the Qbt 1g, Qct, and Qbo sample media group from the Laboratory's BVs and proceed to Section 6.14.

6.13 For PRS samples that contain naturally occurring radionuclides and that were collected from canyon sediment, select the canyon sediment BVs and proceed to Section 6.14.

6.14 Compare the PRS data to selected BVs or FVs.

6.14.1 If the maximum detected activity at the PRS is greater than the BV (or FV), identify the radionuclide as a COPC.

Note: The frequency with which site samples exceed the BVs (or FVs) is required to be reported in the current RFI format.

Note: Sometimes BV (or FV) comparisons identify an analyte as a COPC when it is not different from background. After the BV (or FV) comparison, further statistical tests can be used to evaluate the difference between the distribution of PRS radioactivity concentrations and the background (or fallout) distribution (LANL 1998, 59596.1).

6.14.2 If the maximum detected activity at a PRS is no greater than the BV (or FV), eliminate the radionuclide as a COPC.

Note: Not all differences between PRS data and background data are identified by a BV (or FV) comparison. After the BV (or FV) comparison, further statistical tests can be used to evaluate the difference between the distribution of PRS radioactivity concentrations and the background (or fallout) distribution (LANL 1998, 59596.1).

6.14.3 Document the results of the BV (and/or FV) comparison in the format requested by the focus area.

6.15 **ER Project workers** who are familiar with this SOP may use the logic diagram in Figure 6.15-1 to perform the background value comparison described in the procedure steps listed above.

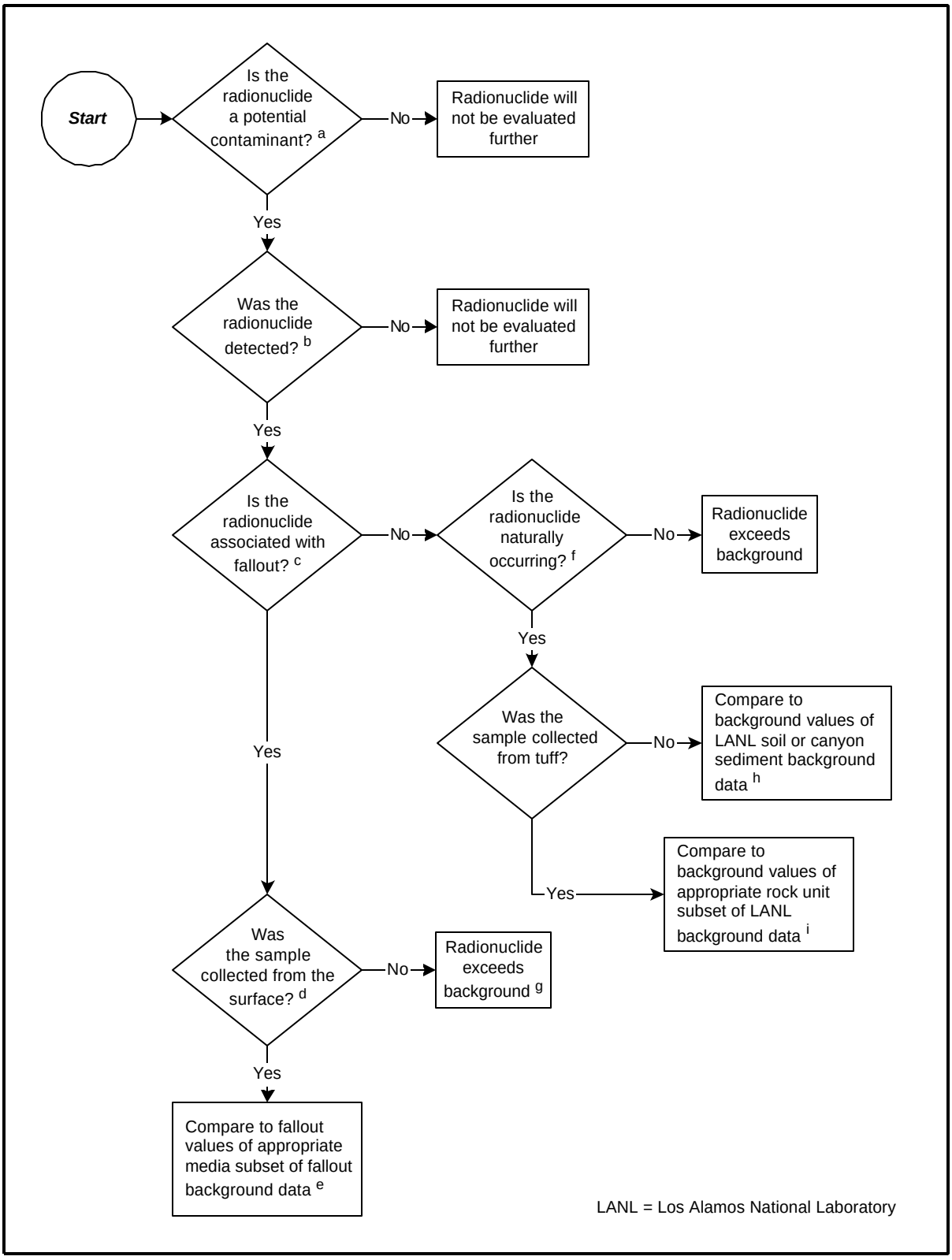

Figure 6.15-1. Logic diagram for selecting radionuclide BVs/FVs

[a] Eliminate radionuclides reported for QA/QC purposes only. If gamma spectroscopy was used, the radionuclides routinely intended for evaluation as potential historical contaminants at the Laboratory are uranium-235, americium-241, cobalt-60, cesium-134, cesium-137, europium-152, sodium-22, and ruthenium-106.

[b] Detection status (and the minimum detectable activity value) should be reviewed during validation to ensure that inadequate counting time or interferences do not cause inappropriate elimination of radionuclides. Check current guidance for determination of detection status for legacy data.

[c] The Laboratory's list of fallout radionuclides includes tritium, cesium-137, americium-241, plutonium-238, plutonium-239/240, and strontium-90.

[d] *Surface* includes sampling intervals starting at depths of zero inches and extending to 6 inches, and other depths that can be reasonably defended as representing (or deriving from) surface locations.

[e] Surface soil samples are compared to soil FVs. Sediment samples are compared to canyon sediment FVs. Tuff samples should be evaluated on the basis of detection status alone for fallout radionuclides. Although there are FVs listed for tuff samples, these values represent nominal minimum detectable activity levels for these radionuclides and will not be used to determine if observed activities exceed background.

[f] The Laboratory's list of naturally occurring radionuclides includes uranium-234, uranium-235, uranium-238, thorium-228, thorium-230, thorium-232, radium-226, and radium-228 (also potassium-40; usually considered a data quality analyte in gamma spectroscopy suite and not evaluated unless identified as a potential contaminant at a PRS).

[g] This conclusion does not apply to samples from canyon sediment (compare to sediment FVs).

[h] Canyon sediment data are compared to canyon sediment BVs; soil samples are compared to soil BVs.

[i] For BV comparisons, the stratigraphic units have been combined into groups. Compare site tuff samples to the BVs from the group that includes the site sample's stratigraphic unit. The categories are (1) Qbt 2, Qbt 3, and Qbt 4; (2) Qbt 1v; and (3) Qbt 1g, Qct, and Qbo.

7.0 REFERENCES

The following documents have been cited within this procedure.

LANL (Los Alamos National Laboratory), July 1995. "Statement of Work–Analytical Support," Revision 2, RFP No. 9-XS1-Q4257, Los Alamos, New Mexico. (LANL 1995, 49738)

LANL (Los Alamos National Laboratory), September 1998. "Statistical Methods for Background Comparisons," draft, Los Alamos National Laboratory study, Los Alamos, New Mexico. (LANL 1998, 59596.1)

QP-2.2, Personnel Orientation and Training

QP-4.2, Standard Operating Procedure Development

Ryti, R. T., P. A. Longmire, D. E. Broxton, S. L. Reneau, and E. V. McDonald, September 1998. "Inorganic and Radionuclide Background Data for Soils, Canyon Sediments, and Bandelier Tuff at Los Alamos National Laboratory," Los Alamos National Laboratory report LA-UR-98-4847, Los Alamos, New Mexico. (Ryti et al. 1998, 59730.2)

ER Project, March 2000. "Approach to Gamma Spectroscopy Data Quality Evaluation," ER Project guidance document, Los Alamos, New Mexico. (ER Project 2000, 65089)

8.0 RECORDS

The results of the BV comparisons are documented in the format requested by the Focus Area, usually in the form of an ER Project report.

9.0 ATTACHMENTS

There are no attachments to this procedure.